Y3.N21/5:14/15

UNIV OF FLORIDA Library

# National Advisory Committee for Aeronautics

# Research Abstracts

NO. 18 FEBRUARY 27, 1952

## CURRENT NACA REPORTS

NACA TN 2519

A COMPARISON OF THE EXPERIMENTAL SUBSONIC PRESSURE DISTRIBUTIONS ABOUT SEVERAL BODIES OF REVOLUTION WITH PRESSURE DISTRIBUTIONS COMPUTED BY MEANS OF THE LINEARIZED THEORY. Clarence W. Matthews. February 1952. 52p. diagrs., tab. (NACA TN 2519. Formerly RM L9F28)

A comparison is made of the theoretical and experimental subsonic compressible pressure-coefficient distributions about several bodies of revolution. The results show that the linearized theory predicts the subsonic pressure coefficients over the central portion of the body. An extrapolation of the theory into the supercritical range does not predict the rearward shift of the negative pressure peak which occurs after the flow becomes critical. Two equations are presented for approximately determining the subsonic compressible pressure-coefficient distributions from the incompressible pressure-coefficient distributions.

NACA TN 2548

EQUAL-STRENGTH DESIGN OF TENSION-FIELD WEBS AND UPRIGHTS. Ralph H. Upson, George M. Phelps and Tung-Sheng Liu, University of Minnesota. January 1952. 46p. diagrs., photos., 4 tabs. (NACA TN 2548)

A method is hereby presented for proportioning thin-web beams to attain equal strength of web and uprights which may in turn be employed toward optimum design of these components. Improved empirical formulas for this purpose are developed and the results checked by experimental loading of six beams. The empirical formulas developed are subject to the limitations of the imposed conditions of this investigation and proportions of uprights as brought out in the experimental results and conclusions.

NACA TN 2602

SURVEY OF THE CHROMIUM-COBALT-NICKEL PHASE DIAGRAM AT 1200° C. W. D. Manly and Paul A. Beck, University of Notre Dame. February 1952. 45p. diagrs., photos., 9 tab. (NACA TN 2602)

A survey of the chromium-cobalt-nickel ternary phase diagram at 1200° C was made by means of microscopic and X-ray diffraction studies on 110 vacuum melted alloys prepared from commercial metals of the highest purity available. At 1200° C, the following phases occur: (1) very extensive face centered cubic solid solutions, based on the binary cobalt-nickel solid solutions; (2) body-centered cubic chromium-base solid solutions; and (3) brittle sigma solid solutions, based on the chromium-cobalt sigma phase which is isomorphous with the iron-chromium sigma phase.

NACA TN 2603

SURVEY OF PORTIONS OF THE COBALT-CHROMIUM-IRON-NICKEL QUATERNARY SYSTEM. E. L. Kamen and Paul A. Beck. February 1952. 62p. photos., diagrs., 13 tabs. (NACA TN 2603)

An isothermal survey was made of certain portions of the chromium-cobalt-nickel-iron quaternary system at 1200° C. The iron content was varied up to 30 percent to include the range of commercial chromium-cobalt-nickel alloys. The component cobalt-chromium-iron ternary system was also studied.

NACA TN 2607

ELECTRICAL PRESSURE INTEGRATOR. Arleigh P. Helfer. January 1952. 44p. photos., diagrs., 2 tabs. (NACA TN 2607)

The design of an instrument that is capable of integration of airfoil pressures into a quantity representative of normal force and pitching moment acting on an airfoil is presented. Flight and wind-tunnel versions of this instrument are described along with samples of test data obtained from them.

NACA TN 2608

CHARTS AND APPROXIMATE FORMULAS FOR THE ESTIMATION OF AEROELASTIC EFFECTS ON THE LOADING OF SWEPT AND UNSWEPT WINGS. Franklin W. Diederich and Kenneth A. Foss. February 1952. 98p. diagrs., 3 tabs. (NACA TN 2608)

Charts are presented for the estimation of aeroelastic effects on spanwise lift distribution, lift-curve slope, aerodynamic center, and damping in roll of swept and unswept wings at subsonic and supersonic speeds. Some design considerations brought out by the results of this paper are discussed.

*AVAILABLE ON LOAN ONLY.

ADDRESS REQUESTS FOR DOCUMENTS TO NACA, 1724 F ST., NW., WASHINGTON 25, D. C, CITING CODE NUMBER ABOVE EACH TITLE, THE REPORT TITLE AND AUTHOR.

NACA TN 2616

THE ACHIEVEMENT OF CONTINUOUS WALL CURVATURE IN DESIGN OF TWO-DIMENSIONAL SYMMETRICAL SUPERSONIC NOZZLES. J. C. Evvard and Lawrence R. Marcus. January 1952. 8p. diagrs. (NACA TN 2616)

Auxiliary boundary conditions were derived to assure continuity of wall curvature in applying the method of characteristics to the design of two-dimensional supersonic nozzles.

NACA TN 2617

RELATIVE IMPORTANCE OF VARIOUS SOURCES OF DEFECT-PRODUCING HYDROGEN INTRODUCED INTO STEEL DURING APPLICATION OF VITREOUS COATINGS. Dwight G. Moore, Mary A. Mason and William N. Harrison, National Bureau of Standards. February 1952. 31p. photos., diagrs., 5 tabs. (NACA TN 2617)

The purpose of this investigation was to study and to determine experimentally the relative importance of various sources of defect-producing hydrogen introduced into steel during the application of vitreous-type ceramic coatings. Under the conditions investigated, the principal source of defect-producing hydrogen was the dissolved water present in the enamel frit of the coating. Acid pickling, milling water, chemically combined water in the clay, and quenching water were all minor sources. Test results indicate that fishscaling, reboil, and possibly primary boil may be eliminated by using a coating prepared with a water-free frit.

NACA TN 2618

CREEP IN METALS. A. D. Schwope, F. R. Shober and L. R. Jackson, Battelle Memorial Institute. February 1952. 52p. diagrs., photos., tab. (NACA TN 2618)

This report covers phases of an investigation of the fundamentals of creep in metals. Results of a study of creep in single crystals of high-purity aluminum are presented and discussed. It is shown that at low stresses the creep phenomenon appears to be consistent with Mott and Nabarro's theory of exhaustion creep while at higher stresses results appear to be more in accord with ideas expressed by Andrade.

NACA TN 2622

A DESCRIPTION AND A COMPARISON OF CERTAIN NONLINEAR CURVE-FITTING TECHNIQUES, WITH APPLICATIONS TO THE ANALYSIS OF TRANSIENT-RESPONSE DATA. Marvin Shinbrot. February 1952. 41p. diagrs., 5 tabs. (NACA TN 2622)

Several least-squares methods for curve fitting a set of data to a nonlinear function are described and compared. Each of the methods is applied to fit data, obtained from a flight test of an actual airplane, to a sum of two exponentials, thus illustrating the use of the methods for the calculation of aircraft stability parameters.

NACA TN 2627

COINCIDENCE METHOD APPLIED TO ION BEAM MEASUREMENT. Stanley Fultz and M. L. Pool. Ohio State University. February 1952. 13p. diagrs. (NACA TN 2627)

A coincidence Geiger counter system was constructed for the absolute measurement of the activity of radioactive substances made in a cyclotron. The average beam current in the cyclotron can be calculated from the number of disintegrations per second observed, the half-life of the radioactive substance, and the reaction cross section.

NACA TN 2628

BONDING OF MOLYBDENUM DISULFIDE TO VARIOUS MATERIALS TO FORM A SOLID LUBRICATING FILM. I - THE BONDING MECHANISM. Douglas Godfrey and Edmond E. Bisson. February 1952. 16p. photos., 4 tabs. (NACA TN 2628)

The use of molybdenum disulfide $MoS_2$ as a solid film lubricant in applications where designs or temperatures preclude liquid lubricants is dependent upon successful bonding of $MoS_2$ to the surface. An experimental investigation was conducted to determine the basic mechanism of bonding $MoS_2$ and extend application of the bonding to a variety of materials. When $MoS_2$ was applied to a surface as a mixture of MoS2 powder and some liquid vehicles, the liquid vehicle decomposed and polymerized to a resin which bound the particles of $MoS_2$ together and to the surface to be lubricated. $MoS_2$ can be bonded by resin-forming viscous liquid vehicles, such as asphalt- and silicone-base varnishes, glycerine, ethylene glycol, polyglycol ether, and corn syrup to a variety of materials, such as steel, aluminum, brass, stainless steel, and glass. The reduction of $Fe_2O_3$, formed by preheating steel in air, to $Fe_3O_4$ by one of the liquid vehicles (syrup) improves the frictional properties of the solid lubricating film. Rubbing of $MoS_2$ whether dusted, built-up, or bonded by a resin to a surface produced distinct preferred orientation.

NACA TN 2629

ANALYTICAL AND EXPERIMENTAL INVESTIGATION OF FULLY DEVELOPED TURBULENT FLOW OF AIR IN A SMOOTH TUBE WITH HEAT TRANSFER WITH VARIABLE FLUID PROPERTIES. R. G. Deissler and C. S. Eian. February 1952. 43p. diagrs. (NACA TN 2629)

A previous analysis of turbulent flow and heat transfer in smooth tubes with variable fluid properties was modified in order to be applicable to air which has a Prandtl number slightly less than unity (0.73). In order to verify the analysis, tests were conducted to determine local heat-transfer coefficients and friction factors for fully developed turbulent flow of air in a smooth electrically heated tube having an inside diameter of 0.87 inch and a length of 87 inches. The tests were conducted at high ratios of wall to fluid bulk temperature. Velocity and temperature

profiles were measured for some conditions. The analytically predicted results were found to agree closely with the experimental results.

NACA TN 2631

THE SIMILARITY LAW FOR NONSTEADY HYPERSONIC FLOWS AND REQUIREMENTS FOR THE DYNAMICAL SIMILARITY OF RELATED BODIES IN FREE FLIGHT. Frank M. Hamaker and Thomas J. Wong. February 1952. 24p. diagrs. (NACA TN 2631)

The hypersonic similarity law for steady flow is extended to include nonsteady flows. The aerodynamic forces are correlated by this law and this correlation is used to derive conditions for dynamical similarity of the motions of related bodies in free flight. The correlation of flight paths was achieved on this basis.

NACA TN 2634

EVALUATION OF THREE METHODS FOR DETERMINING DYNAMIC CHARACTERISTICS OF A TURBOJET ENGINE. Gene J. Delio. February 1952. 56p. diagrs., 6 tabs. (NACA TN 2634)

Data resulting from approximate step and sinusoidal disturbances of fuel flow of a turbojet engine were analyzed by three methods: approximate indicial responses were used in determining the coefficients of differential equations, Fourier analysis was performed on the transient data, and AC analysis was performed using steady-state frequency response data. Transfer functions are derived from functional relationships describing turbojet engine dynamic behavior resulting from changes of several manipulated variables. Engine nonlinearities and supply source regulation are considered.

NACA RM E51J30

PRELIMINARY INVESTIGATION OF CYCLIC DE-ICING OF AN AIRFOIL USING AN EXTERNAL ELECTRIC HEATER. James P. Lewis and Dean T. Bowden. February 1952. 43p. photos., diagrs. (NACA RM E51J30)

An investigation was conducted in the NACA Lewis icing research tunnel to determine the characteristics and requirements of cyclic de-icing of an airfoil by use of an external electric heater. The present investigation was limited to an airspeed of 175 miles per hour. Data are presented to show the effects of variations in heat-on and heat-off periods, ambient air temperature, liquid-water content, angle of attack and heating distribution on the requirements for cyclic de-icing. The external heat flow at various icing and heating conditions is also presented. A continuously heated parting strip at the airfoil leading edge was found necessary for quick, complete, and consistent ice removal. The cyclic power requirements were found to be primarily a function of the datum temperature and heat-on time, with the other operating and meteorological variables having a second-order effect. Short heat-on periods and high power densities resulted in the most efficient ice removal, the minimum energy input, and the minimum runback ice formations.

NACA TM 1300

WIND-TUNNEL CORRECTIONS AT HIGH SUBSONIC SPEEDS PARTICULARLY FOR AN ENCLOSED CIRCULAR TUNNEL. (Windkanalkorrekturen bei hohen Unterschallgeschwindigkeiten unter besonderer Berücksichtigung des geschlossenen kreiskanals). B. Göthert. February 1952. 43p. diagrs., 3 tabs. (NACA TM 1300. Trans. from Zentrale für wissenschaftliches Berichtswesen der Luftfahrtforschung, Berlin. FB 1216; Deutsche Versuchsanstalt für Luftfahrt E. V., Berlin. Institut für Aerodynamik, May 16, 1940).

A review of existing publications on wind-tunnel corrections is followed by an approximate method for determining the corrections due to model and wake displacement and to lift. Relations are investigated for fuselages and wings of various spans in closed circular tunnels. A comparison is made between the computations and the tests in the DVL high-speed wind tunnel.

NACA TM 1328

CONCERNING THE FLOW ABOUT RING-SHAPED COWLINGS. PART VIII - FURTHER MEASUREMENTS ON ANNULAR PROFILES. (Über die Strömung an ringförmigen Verkleidungen. VIII Mitteilung: Weitere Messungen an Ringprofilen). Dietrich Küchemann and Johanna Weber. February 1952. 11p. diagrs. (NACA TM 1328. Trans from Zentrale für wissenschaftliches Berichtswesen der Luftfahrtforschung, Berlin. FB 1236/8, March 25, 1943).

The measurements of part V (reference 1) of this series of reports, which concerned comparatively long ring profiles, are supplemented by measurements on shorter rings as they are used for shrouded propellers and cowlings of ring-shaped radiators. Mass-flow coefficients and profile drags are given. Furthermore, it has to be determined how far the potential theory describes the flow phenomenon with sufficient accuracy and whether the present theory for the calculation of thin annular profiles yields useful profile forms and is suitable for determination of the mass flow for thick profiles.

## BRITISH REPORTS

N-11515A*

College of Aeronautics, Cranfield (Gt. Brit.)
THE MEASUREMENT OF THE DERIVATIVE $Z_{\dot{w}}$ FOR AN OSCILLATING AEROFOIL. A. L. Buchan, K. D. Harris and P. M. Somervail. June 1950. 32p. diagrs. (College of Aeronautics, Cranfield. Rept. 40)

Presents results of experimental measurements of the damping derivative coefficient for constant chord rigid wings of various aspect ratios having sweepback angles of zero and 45°. The results for the rectangular wings show substantial agreement with the unsteady airfoil theory developed by W. P. Jones. The dependence of $W_z$ upon frequency parameter is as given by theory and is much less than for two-dimensional flow, but the numerical results are approximately 10 percent below the theoretical. The effect of sweepback is to decrease the numerical value, but this effect is more pronounced for low than for high aspect ratios.

N-11533*

Aeronautical Research Council (Gt. Brit.)
CREEP TESTS ON SOME CAST MAGNESIUM ALLOYS. PARTS I, II AND III. A. E. Johnson and H. J. Tapsell. 1951. 22p. diagrs., tabs. (ARC R & M 2675; ARC 8281; ARC 8306. Formerly ARC 7595; ARC A.459)

Results of creep tests of 150 hours duration at 100°, 150° and 200° C on some heat-treated sand cast magnesium alloys are presented. A comparison of the creep properties of three cast magnesium alloys based on tests of 1000 hours duration is made. Finally results are presented of short-time creep tests at 3 tons/sq in. of four cast magnesium alloys having different heat treatments.

N-13037*

Aeronautical Research Council (Gt. Brit.)
SANDWICH CONSTRUCTION - A PRACTICAL APPROACH FOR THE USE OF DESIGNERS. D. Williams. 1951. 25p. diagrs. (ARC R & M 2466; ARC 10,384. Formerly RAE Structures 2)

Formulas for the design of sandwich panels are derived. The approximations used reduce the accuracy of the results to only a negligible degree. The qualities both of stiffness and strength desirable in core materials (homogeneous or grained) are discussed, and suggestions for future developments are made. It is shown that very high efficiencies are obtainable with a core material having elastic moduli some 500 less than those of dural, even though the density may be as much as 1/100 that of duralumin.

N-13039*

Aeronautical Research Council (Gt. Brit.)
STRAIN GAUGE INVESTIGATION OF PROPELLER FLUTTER. L. H. G. Sterne, H. G. Ewing and J. Kettlewell. 1951. 7p. diagrs. (ARC R & M 2472; ARC 10,567. Formerly RAE SME 3399)

This report describes strain-gage tests on a fluttering propeller. The tests were made on the No. 3 spinning tower and also in the large wind tunnel at the Royal Aircraft Establishment. The propeller blades were made of compressed wood. Both low incidence and stalling flutter were detected, and examples of the wave forms recorded by an oscilloscope and corresponding to each type of flutter are given.

N-13041*

Aeronautical Research Council (Gt. Brit.)
AN INVESTIGATION IN FLIGHT OF THE INDUCED VELOCITY DISTRIBUTION UNDER A HELICOPTER ROTOR WHEN HOVERING. P. Brotherhood. 1951. 16p. photos., diagrs. (ARC R & M 2521. Formerly RAE Aero 2212; ARC 10,838; ARC H58)

Flight tests have been made on a Sikorsky R-4B helicopter to determine the distribution of the velocity induced by the rotor in hovering flight. Measurements in the fully developed slipstream were referred back to their appropriate disk positions by means of smoke visualization of the streamlines. The experimental distribution agrees very well with that predicted by propeller strip theory, provided the tip loss is taken into account.

N-13043*

Aeronautical Research Council (Gt. Brit.)
PHOTO-ELASTIC EXAMINATION OF A CYLINDRICAL STRUT INTENDED FOR RECORDING COMPRESSIVE LOADS. W. A. P. Fisher. 1951. 4p. photos., diagrs. (ARC R & M 2532; ARC 11,485. Formerly RAE SME 3400)

Photoelastic methods are used to establish how much of a cylindrical steel strut, mounted for measurement of compressive force by strain gages, has uniform stress distribution, even when the end load is concentrated near the axis of the strut. It is found that a strut 16 inches long, and 6-inch diameter has virtually uniform stress distribution over the middle 2-1/2 inches.

N-13044*

Aeronautical Research Council (Gt. Brit.)
NOTE ON THE EFFECT OF BOUNDARY-LAYER SUCTION ON SEPARATION. E. J. Watson. 1951. 2p. diagrs. (ARC R & M 2538. Formerly ARC 10,606; FM 1107)

Presents a discussion of the general character of flow near the separation point. It shows the main disadvantage of the proposed separation condition in applying it to boundary-layer calculations.

N-13045*

Aeronautical Research Council (Gt. Brit.)
THE BEHAVIOUR IN COMPRESSION OF ALUMINIUM ALLOY PANELS HAVING A FLAT SKIN WITH CORRUGATED REINFORCEMENT. E. A. Brook. 1951. 33p. diagrs., photos., 8 tabs. (ARC R & M 2598; ARC 9013. Formerly RAE SME 3333)

This describes tests on 36 panels. Each panel consisted of a flat skin reinforced with continuous corrugations, and the object of the test was to investigate the effect of rivet pitch and arrangement, corrugation width, and skin and corrugation thickness on the buckling and failing loads of the panels. The results indicate that for the thickness of skin and corrugations considered, the interrivet buckling stress

is considerably less than the stress at which the skin between rivets would buckle, when considered as an Euler strut with encastre ends.

N-13046*

Aeronautical Research Council (Gt. Brit.)
STRESS DIFFUSION ADJACENT TO GAPS IN THE INTER-SPAR SKIN OF A STRESSED-SKIN WING. M. Fine and H. G. Hopkins. 1951. 13p. diagrs. (ARC R & M 2618; ARC 5941. Formerly RAE SME 3208)

This report gives, subject to certain simplifications, a theoretical analysis of the problem of stress concentrations due to cut-outs and gaps in the wing surface. Approximate formulas are found for the direct stress in the flanges and the shear stress in the skin at the flanges and at the chordwise gap. A numerical example to illustrate the application to design is given. Although various factors are likely to reduce the stress concentration if the present calculations predict it to be high, some reinforcement of the skin is likely to be necessary.

N-13047*

Aeronautical Research Council (Gt. Brit.)
A NOTE ON A ROTATING BENDING-FATIGUE MACHINE FOR TESTS AT 200 DEG. C. C. E. Phillips and R. C. A. Thurston. 1951. 4p. diagrs., photos. (ARC R & M 2674; ARC 8592)

An experimental adaptation of an air temperature rotating bending-fatigue testing machine has been made for tests on light alloys at temperatures up to 200° C. The machine is described and results of preliminary tests are discussed.

N-13059*

Aeronautical Research Council (Gt. Brit.)
FOCUSSING SCHLIEREN SYSTEMS. R. W. Fish and K. Parnham. 1951. 17p. diagrs. (ARC CP 54; ARC 13, 865. Formerly RAE Tech. Note IAP 999)

The substitution of grids for the usual knife edges in a Schlieren apparatus confers focusing properties on the system. Three possible systems are described and their optical limitations discussed. Achromatic lenses are used in place of mirrors because of the excessive off-axis aberrations of the mirrors. Some practical suggestions for the construction of the grid and the adjustment of the system are given.

N-13322*

Royal Aircraft Establishment (Gt. Brit.)
EVAPORATION FROM THE SURFACE OF A BODY IN AN AIRSTREAM. (WITH PARTICULAR REFERENCE TO THE CHEMICAL METHOD OF INDICATING BOUNDARY LAYER TRANSITION.) P. R. Owen and A. O. Ormerod. September 1951. 61p. diagrs. (RAE Aero 2431)

The problem of predicting the rate of transport of a gas from or into the surface of a two-dimensional body in an air stream is discussed. The principal object of the investigation is to provide a means of estimating the time required to obtain an experimental record of boundary layer transition when a chemical technique is used. The methods evolved should, however, find an application to other forced diffusion phenomena. Experimental results are compared with theoretical ones. A calculation of the effect of altitude is made.

N-13323*

Royal Aircraft Establishment (Gt. Brit.)
CALCULATION OF THE PRESSURE DISTRIBUTION OVER A WING AT SONIC SPEEDS. K. W. Mangler. September 1951. 94p. diagrs., 3 tabs. (RAE Aero 2439)

A method is developed for the calculation of the pressure distribution and the aerodynamic forces and moments acting on a wing at incidence, in steady roll, and in steady pitch. The calculation assumes an inviscid potential flow and is restricted to small incidence and thickness ratio. Calculations indicate the plan form is as important to pressure distribution at sonic speeds as the chordwise section is at subsonic speeds for wings of larger aspect ratios. Although the calculation is based in the assumption of an inviscid flow without shock waves, the results are thought to be useful for showing the main trends of the behavior of a wing near sonic speed.

N-13369*

Royal Aircraft Establishment (Gt. Brit.)
SOME OBSERVATIONS ON THE CREEP OF SINGLE CRYSTALS OF AN ALUMINIUM-SILVER ALLOY. L. Rotherham, A. R. Sollars and N. H. G. Daniels. July 1951. 27p. photos., diagrs. (RAE Tech. Note Met.148)

Creep tests have been carried out, at 300° C, 400° C, and 450° C, under constant load conditions, on single crystals of aluminum - 0.5 percent silver solid solution. Breakdown into substructure has been conclusively demonstrated, together with slip lines, step bands and deformation bands.

## UNPUBLISHED PAPERS

N-9479*

CONTRIBUTION TO THE NONSTEADY LAMINAR BOUNDARY LAYER ON PLANE WALLS. (Beitrag zur instationären laminaren Grenzschicht an ebenen Wänden). W. Wuest. January 1952. 14p. diagrs. (Trans from Ingenieur-Archiv, v. 17, no. 3, 1949, p. 193-198).

The development of a laminar boundary layer is investigated in the neighborhood of plane walls or at the contact surface of two fluids. Aside from dependence

on time, a dependence on distance from the wall is assumed. Also investigated is a nonsteady analogue to the boundary layer suction in the steady case which is dependent upon distance along the wall. The flow at the contact surface between two fluids of different density and velocity is discussed. The results show that the ratio of the contact-surface velocity and the velocity outside of the boundary layer is independent of time.

N-10898*

APPLICATION OF THIN-WING EXPANSION METHOD TO GAS FLOW ALONG SINUSOIDAL WALL. (Seigempakei no Kabe ni Ou Kosokikiryu ni Tsuite). Isao Imai and Seiichi Oyama. 16p. diagrs. (Trans. from Tokyo (Imperial) Univ., Institute of Science and Technology, Reports, v. 2, no. 3-4, Mar.-Apr., 1948, p. 39-44).

To investigate a high velocity fluid the thin-wing expansion method carried to the third approximation was applied to flow along a sinusoidal wall. By varying $\epsilon$ and M the flow conditions could be studied. Because the factor $\mu^3$ is involved as the approximation is carried further, it is difficult to predict anything definite for the case M near 1. According to numerical results a continuous solution exists for the case of a supersonic zone; but the curvature of the velocity distribution curves at the points of maximum velocity becomes infinite, shock waves arise, and the convergence of the solution is disrupted.

N-12506*

National Advisory Committee for Aeronautics. THE ROLE OF PHYSICS IN AERONAUTICAL DEVELOPMENT. Hugh L. Dryden. 56p. photos., diagrs. (Presented before American Association for the Advancement of Science, at conference on Applied Physics, Municipal Auditorium, Philadelphia, December 27, 1951).

In order to stimulate the physicist's interest in the field of aeronautics a few examples are given of the applications of existing physical knowledge, of problems in physics arising from the resolution of engineering problems into their component subproblems, and of the great indebtedness of aeronautics to physics for its tools of measurement. For security reasons and to fulfill better the aims of the paper, emphasis has been placed on the longer range problems.

## DECLASSIFIED NACA REPORTS

NACA RM E8A29a

INTERNAL-FILM COOLING OF ROCKET NOZZLES. J. L. Sloop and George R. Kinney. June 8, 1948. 40p. diagrs., photos. (NACA RM E8A29a) (Declassified from Restricted, 1/3/52)

Experiments were conducted with a 1000-pound-thrust rocket engine to determine the feasibility of cooling convergent-divergent nozzles by internal film of water introduced at nozzle entrance. Water flow of 3 percent of propellant flow reduced heat flow into nozzle to 55 percent of uncooled heat flow. Introduction of water by porous ring before the nozzle resulted in more uniform coverage of nozzle than water introduced by single arrangement of 36 jets directed along nozzle wall. Water flow through a porous ring of 3.5 percent of propellant flow stabilized wall temperature in convergent section but did not adequately cool throat or divergent sections.

NACA RM E8F01

PHOTOGRAPHIC STUDY OF COMBUSTION IN A ROCKET ENGINE. I - VARIATION IN COMBUSTION OF LIQUID OXYGEN AND GASOLINE WITH SEVEN METHODS OF PROPELLANT INJECTION. Donald R. Bellman and Jack C. Humphrey. August 26, 1948. 51p. photos., diagrs., tab. (NACA RM E8F01) (Declassified from Restricted, 1/3/52)

Motion pictures up to 3000 frames per second were taken of the combustion of liquid oxygen and gasoline in a 100-pound thrust rocket engine. The effect of seven methods of propellant injection on the uniformity of combustion was investigated. The flame front was generally found to extend to the injector faces and all the injection systems showed considerable nonuniformity of combustion. Pressure vibration records indicated combustion vibrations that corresponded to resonant-chamber frequencies.

NACA RM E50F19

INTERNAL-FILM-COOLING EXPERIMENTS IN 4-INCH DUCT WITH GAS TEMPERATURES TO 2000° F. George R. Kinney and John L. Sloop. September 21, 1950. 34p. diagrs., tab. (NACA RM E50F19) (Declassified from Restricted, 1/3/52)

An investigation of film cooling was conducted in a 4-inch-diameter duct at gas temperatures from 600° to 2000° F and Reynolds numbers from 400,000 to 1,400,000. The coolants were water and ethylene glycol at flows of 1 to 6 percent of the gas flow. During vaporization of the liquid film, coolants kept the duct wall below the boiling temperature of the liquid; little additional duct cooling was obtained from coolant vapor alone. Data were generalized over part of the coolant-flow range by use of heat-transfer relations in a form that facilitates prediction of coolant flow required to film-cool a duct for a desired length when temperature and flow of the hot gas are known.

NACA RM E51C13

INVESTIGATION OF ANNULAR LIQUID FLOW WITH COCURRENT AIR FLOW IN HORIZONTAL TUBES. George R. Kinney and Andrew E. Abramson. May 25, 1952. 33p. diagrs., photos., 2 tabs. (NACA RM E51C13) (Declassified from Restricted, 1/3/52)

Visual observations and flow analyses were made of annular liquid flow with cocurrent air flow in horizontal tubes. Experiments were conducted with air temperatures of 80°, 475°, and 800° F, air-stream Reynolds numbers from 410,000 to 2,900,000, and liquid flows from 0.3 to 21 percent of air flows. Annular liquid films were approximately 0.0005 to 0.005 inch thick. Film surface changed from relatively smooth with the liquid annulus in the region where viscous forces are appreciable to disturbed where turbulent forces are predominant. Change in cooling effectiveness of liquid films in film-cooling experiments was related to film-surface change; surface condition could be predicted approximately knowing liquid flow and viscosity.

NACA RM L8D01

AERODYNAMIC CHARACTERISTICS OF A TWO-BLADE NACA 10-(3)(12)-03 PROPELLER. W. H. Gray and A. E. Allis. August 30, 1948. 27p. diagrs., tab. (NACA RM L8D01) (Declassified from Restricted, 12/28/51)

Contains results of wind-tunnel tests of the NACA 10-(3)(12)-03 propeller. The particular blade design, the tests of which are described, was one necessary to the investigation of the effect of differences in blade-thickness ratios. A maximum efficiency of 0.91 was attained at a constant rotational speed of 1140 rpm. Peak efficiency, at a blade angle of 45°, was decreased 26 percent by a helical tip Mach number increase from 0.81 to 1.10.

NACA-Langley - 2-27-52 -3500

UNIVERSITY OF FLORIDA
3 1262 09079 7589